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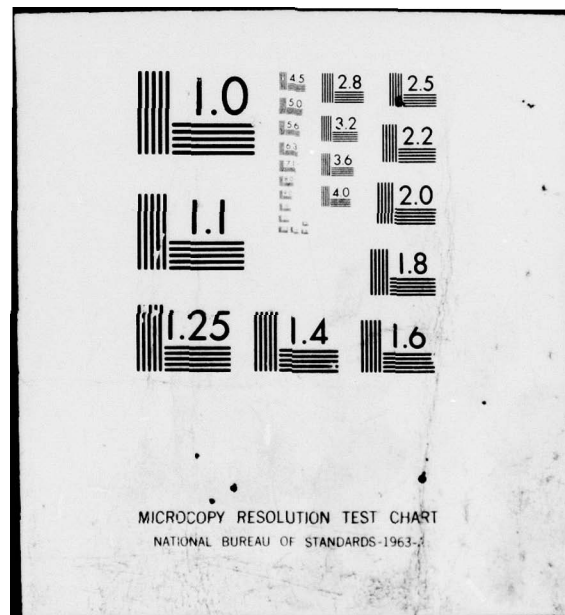
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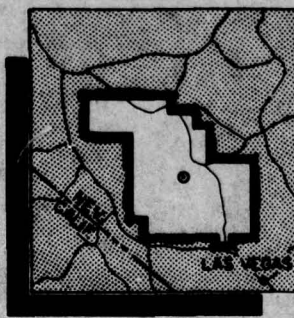
March - June 1953

Project 6.10

EVALUATION OF RAPID AERIAL RADIOLOGICAL  
SURVEY TECHNIQUES

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OPERATION UPSHOT-KNOTHOLE

Project 6.10

EVALUATION OF RAPID AERIAL  
RADIOLOGICAL SURVEY TECHNIQUES

REPORT TO THE TEST DIRECTOR

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BY B. Wade, 23 Sep 64/63

John R. Price, Lt., USA

May 1954

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ABSTRACT

Plots of gamma exposure rates due to ground contamination following nuclear detonations were readily obtained by using a standard radiac instrument and employing simple techniques in a rapid aerial survey utilizing light aircraft. This survey consisted of recording exposure rates every five seconds on each leg of a cloverleaf pattern centered over ground zero to obtain the fallout pattern and then taking readings over ground zero at several different altitudes for use in plotting an extrapolation curve. With this curve all data obtained in the air were converted to surface exposure rates.

Standard extrapolation curves should be prepared for each type of burst based on data accumulated from aerial surveys. With the data obtained on this operation, a standard extrapolation curve was developed for near surface bursts. This curve provides an approximate means of converting to surface exposure rates after obtaining data at only one altitude and should be used when specific extrapolation data is not available. However conversion factors obtained by making vertical descents over key areas are more accurate.

Helicopters are preferred to conventional aircraft. Pseudo-logarithmic scaled instruments are more suitable than linear scaled instruments. It is desirable to record the data with a pencil rather than to use a more complicated recording system. A predetermined correction factor is adequate to correct for the attenuation of gamma radiation by light aircraft.

Aerial surveys are relatively brief and since they are conducted at altitudes where the radiation is greatly attenuated, the monitors receive only a small percentage of the exposure they would receive conducting an equivalent ground survey. The results agree within a factor of ten with those obtained by the Rad-Safe ground survey teams.

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#### FOREWORD

This report is one of the reports presenting the results of the 78 projects participating in the Military Effects Tests Program of Operation UPSHOT-KNOTHOLE, which included 11 test detonations. For readers interested in other pertinent test information, reference is made to WT-782, Summary Report of the Technical Director, Military Effects Program. This summary report includes the following information of possible general interest.

- a. An over-all description of each detonation, including yield, height of burst, ground zero location, time of detonation, ambient atmospheric conditions at detonation, etc., for the 11 shots.
- b. Compilation and correlation of all project results on the basic measurements of blast and shock, thermal radiation, and nuclear radiation.
- c. Compilation and correlation of the various project results on weapons effects.
- d. A summary of each project, including objectives and results.
- e. A complete listing of all reports covering the Military Effects Tests Program.

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## CHAPTER 1

### INTRODUCTION

#### 1.1 OBJECTIVE

The object was to further simplify and develop the techniques used in performing a rapid aerial radiological survey that were employed during JANGLE and SNAPPER, <sup>1</sup>, <sup>2</sup>. Furthermore it was proposed that an empirical extrapolation curve for near surface bursts be developed from data taken at UPSHOT-KNOTHOLE.

#### 1.2 BACKGROUND

The basic techniques for performing a rapid aerial survey were developed during JANGLE and SNAPPER. On JANGLE it was shown that exposure rates obtained using a simple radiac instrument, DC amplifier, and recorder and then adjusted to ground values by means of an extrapolation curve agreed with values obtained on the ground sufficiently well to warrant further testing. On SNAPPER the DC amplifier and recorder was replaced by a stopwatch, data sheet, and pencil. It was suggested that a radiac instrument with a logarithmic scale be used to avoid the loss of data resulting from scale switching. The monitoring personnel were limited to a total exposure of 3.9 r for the entire operation. As a result the surveys were performed at higher altitudes than might be necessary under tactical conditions.

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<sup>1</sup>Project 6.1, Operation JANGLE, WT-337, Evaluation of Military Radiac Equipment (Confidential)

<sup>2</sup>Project 6.1, Operation SNAPPER, WT-532, Evaluation of Military Radiac Equipment (Confidential)

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## CHAPTER 2

### INSTRUMENTATION AND OPERATIONS

#### 2.1 EQUIPMENT SYSTEMS

Two equipment systems were compared during the course of this operation:

1. The output of a modified Radiac Training Set AN/PDR TIB was fed through a DC amplifier into an Esterline Angus recorder comprising the electromechanical recording system.

2. A standard radiac set was used in conjunction with a stop-watch data sheet, and a pencil comprising the manual recording system.

#### 2.2 RADIAC INSTRUMENTS

Two sets with psuedo-logarithmic scales, the IM-71 and the AN/PDR-32, and two sets with linear scales, the AN/PDR-39 and the AN/PDR-18 were used to determine whether linear or logarithmic scaled radiac instruments are more suitable for conducting an aerial survey.<sup>1</sup>

#### 2.3 ATTENUATION BY AIRCRAFT

An effort was made to determine the influence of the aircraft on radiac instrument readings taken inside. Film badges were placed at various locations opposite one another on the interior and exterior of a USAF C-45 and a Marine HRS-2 Helicopter, which is identical to the Army H-19. The ratio of the total exposures provided a correction factor for the observed readings.

#### 2.4 FORMER SURVEY TECHNIQUES

The techniques of JANGLE and SNAPPER were employed for two events. A C-45 aircraft entered the contaminated area at about 500 feet and circled around ground zero about  $\frac{1}{2}$  mile away to select a

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<sup>1</sup>Project 6.8, Operation UPSHOT-KNOTHOLE, WT-755, Evaluation of Military Radiac Equipment (Confidential)

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landmark at or near ground zero as a datum point and to ascertain the direction of maximum fallout. The approximate level of contamination was noted and the altitude of operation was decided upon.

The aircraft then flew a cloverleaf pattern centered over the datum point at three different altitudes (see Fig. 3.4). The first leg of the cloverleaf patterns passed over the datum point in the direction of maximum fallout. Air speed, direction and altitude were kept constant on each leg of the pattern.

Monitors in the aircraft obtained data by using the mechanical recording system and by writing exposure readings on a data sheet every five seconds. A notation was made on the data sheet as the plane passed over the datum point.

The distance away from the datum point was obtained by multiplying the speed of the aircraft by the time between readings. Corrections for wind velocity were not made, although it may be desirable to make such corrections under some circumstances. Equivalent ground data were obtained by extrapolating from data taken at three different altitudes.

The T-1.2 decay law was considered applicable and was used to adjust the data from survey time to other times of interest. The data were plotted on polar coordinate paper and contour lines were drawn.

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## CHAPTER 3

### RESULTS AND DISCUSSIONS

#### 3.1 HELICOPTERS

Simplifications of the aerial survey brought into use a Marine HRS-2 Helicopter and an Army H-23 Helicopter. The helicopter flew a cloverleaf pattern at one altitude only, substituting a vertical descent or its equivalent for additional surveys at other altitudes. It was found that most accurate extrapolation data was obtained by making the descent in 100 ft. intervals on each leg of a figure eight pattern that criss-crossed over a reference point. Conventional aircraft may be used to obtain extrapolation data in this manner but they are not as suitable as helicopters. Using this method, the survey required less time, the data was evaluated more rapidly and the monitoring personnel received less gamma dosage. The C-45 and the HRS-2 are larger than the H-23 and have a greater range but it was difficult for the monitor to coordinate with the pilot during the survey. Since the cruising speed of the helicopters was about half that of the C-45, the monitor was able to obtain twice the number of readings which improved the accuracy of the survey. The H-23 provided the monitor with the additional advantages of greater visibility and better coordination with the pilot since they were seated side by side.

#### 3.2 EXTRAPOLATION FACTORS

Because of the difficulties in locating the relative positions of surveys taken at three altitudes, the extrapolation factors so derived may be inaccurate. A vertical descent results in an extrapolation factor which is more accurate in the region from which it was obtained. However, it may not be as accurate in other regions since the measurements are influenced by the entire contaminated area located near the detector and not just the area directly below. A contaminated area will raise the radiation rates above adjacent areas more, proportionally, than it will raise the radiation rates on the surface. This results because the surface areas are partially shielded by the uneven terrain and because the radiation must be scattered through greater angles to affect the surface rates. Consequently the

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extrapolation factor obtained from the data gathered above a small highly contaminated area will often be too large for the adjacent areas with less contamination. It is desirable therefore to obtain more than one extrapolation factor. For example, one factor may be obtained for the area near ground zero and another for the downwind fallout area or one factor may be obtained in the 100 r/hr region and another near the 1 r/hr region.

In order to limit the dosage of monitoring personnel to tolerable levels or to make the survey move rapidly, it may be necessary to eliminate the vertical descents altogether. Figure 3.1 shows that the extrapolation curves obtained on UPSHOT-KNOTHOLE are essentially linear when plotted on semi-logarithmic paper. Taking an average curve and plotting its reciprocal as shown in Figure 3.2, we obtain a standard extrapolation curve which may be used if specific extrapolation data is not available.

### 3.3 SPECIAL TECHNIQUES

Readings were taken over landmarks such as road crossings, motels, and bridge structures and entered on data sheets or directly on maps showing these features. These landmarks provided additional datum points for locating the survey pattern. The aerial surveys were performed at the lowest altitudes possible commensurate with Rad-Safe considerations. In areas of light contamination the helicopters descended to 25 ft. and obtained readings near landmarks.

### 3.4 AIRBORNE RADIOACTIVE CONTAMINATION

Most contaminated particles in a radioactive cloud rise to considerable height and thus the fallout extends over an appreciable time. An aerial survey conducted during the first few hours after a detonation may be adversely affected by contaminants suspended in air. However, these particles disperse and decay rapidly so that after a few hours errors in survey resulting from non-uniform distribution of airborne contaminants are probably small. Interference from airborne contaminants may be minimized by performing the survey immediately before the results are required.

### 3.5 EVALUATION OF EQUIPMENT SYSTEMS

The results obtained on Shot 1 and Shot 2 substantiated the conclusions reached at SNAPPER that the radiac set and stopwatch method is preferred to the radiac set, DC amplifier, and recorder method. The manual method of recording data requires equipment which is readily available and results in data which can be easily interpreted with little difference in the overall accuracy.

### 3.6 EVALUATION OF RADIAC INSTRUMENTS

Radiac instruments used in aerial surveys must be able to cover a wide variation in exposure rates very quickly. The AN/PDR-39 and

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the AN/PDR-18 were used as representative of those instruments with linear scales. Since the scale covers only one decade it is necessary to switch scales when the readings are changing rapidly. The time required for scale switching and the transient currents produced by scale switching are of such duration that important data are often missed. The IM-71/PD and the AN/PDR-32 (XE-3) were chosen as representative of those instruments with psuedo-logarithmic scales. These instruments proved to be satisfactory in that they covered four or five decades of exposure rates on one scale and that the time constants of the instruments were adequate for the speeds involved with light aircraft. The IM-71/PD and the AN/PDR-32 (XE-3) had the added attraction of being smaller and lighter than the other types of radiac instruments.

### 3.7 GAMMA ABSORPTION BY AIRCRAFT

Table 3.1 presents the exposure readings obtained from film badges placed at various locations on a survey aircraft. The reduction in exposure rate is dependent on the location of the radiac set. In order to provide a correction for this factor, dosimeters were mounted near the radiac set, one inside the aircraft, another outside. The ratio of the total exposures provided a correction factor for the radiacmeter readings within the limitations of the relative responses of the dosimeter and the survey meter. This correction factor may also be determined experimentally by holding a survey instrument at arms length outside of a helicopter or by landing in a lightly contaminated area and taking readings inside and outside of the helicopter. It may be desirable to determine this factor experimentally for survey aircraft and to apply this predetermined factor. This factor however may be a function of the type of weapon and detonation because of differences in spectral quality.

TABLE 3.1 - Film Badge Locations vs Exposure for HRS-2 Helicopter

Outside	Exp. (r)	Inside	Exp. (r)
Left Front	2.4	Left Front	1.5
Left Rear	2.3	Left Rear	1.2
Right Front	2.6	Right Front	1.2
Right Rear	3.0	Right Rear	1.4
Right Side Rear	2.0	Right Side Rear	1.8
Right Side Front	1.6	Right Side Front	1.4
Left Side Rear	2.2	Left Side Rear	2.0
Left Side Front	2.2	Left Side Front	2.0
Right Tail	1.8		
Left Tail	1.9		
Nose	2.3		

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### 3.8 SUSPENDED PROBE DEVICES

A moderately contaminated area may be surveyed by suspending a probe from a low flying helicopter to within a few feet of the surface. A probe used in conjunction with a long cable and a reel may also be of value in obtaining extrapolation data on high altitude surveys. The effects of absorption and scattering by aircraft would be eliminated. However under tactical conditions these advantages may be offset by the complications arising from the special equipment required and the additional survey problems encountered.

### 3.9 DATA PRESENTATION

Figures 3.3 and 3.4 compare the radiological contours obtained from the aerial surveys with those obtained from the Rad-Safe ground surveys for Shots 2, 7, 8, 9, and 10. There was no participation on the other events. It is evident that the aerial surveys give iso-rate contours of the proper shape and that the exposure rate values are accurate within a factor of ten.

Appendix A presents the raw data from Shot 10 and carries out the analysis step by step that results in the finished contour map presented in Figure 3.4.

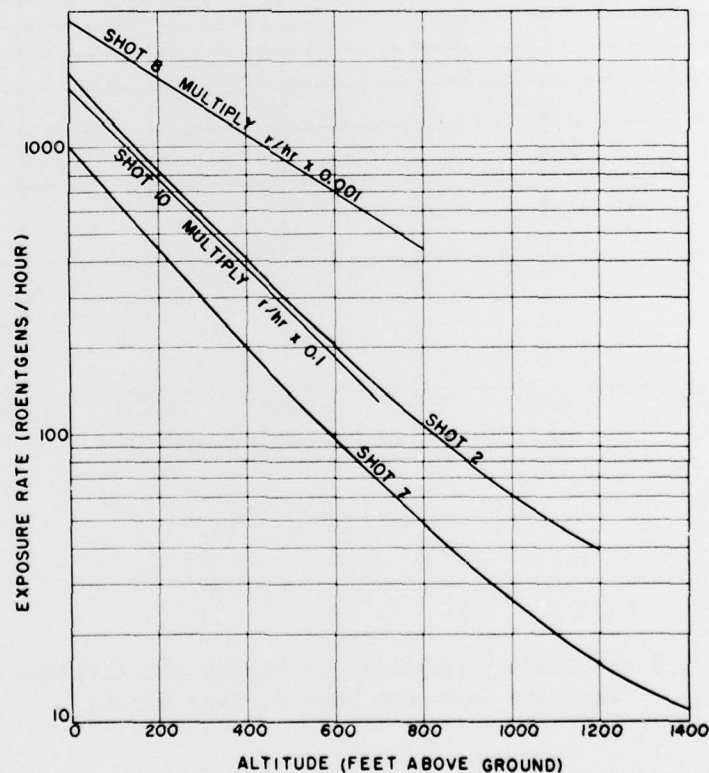


Fig. 3.1 Extrapolation Curves for Near Surface Bursts

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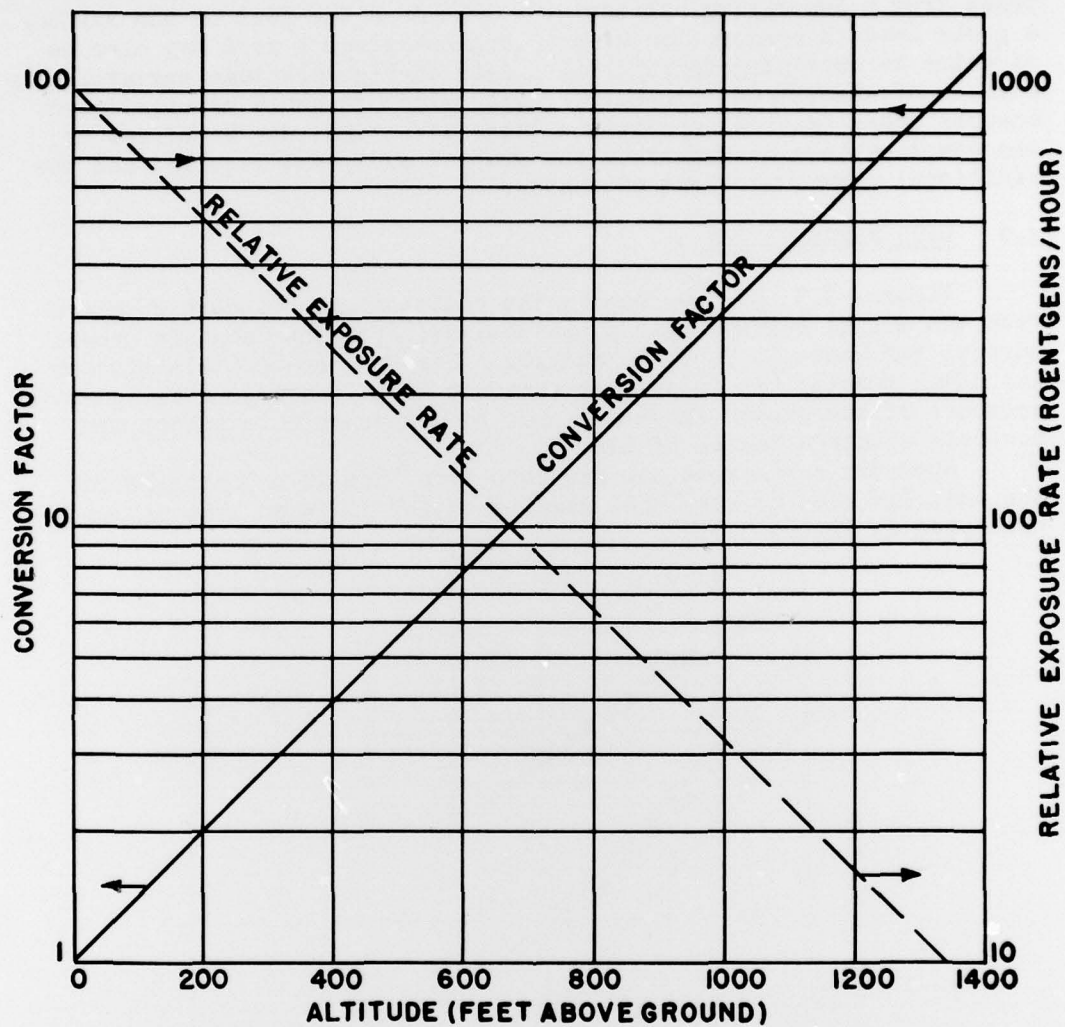


Fig. 3.2 Altitude vs Conversion Factor and Altitude vs Exposure Rate for Near Surface Bursts

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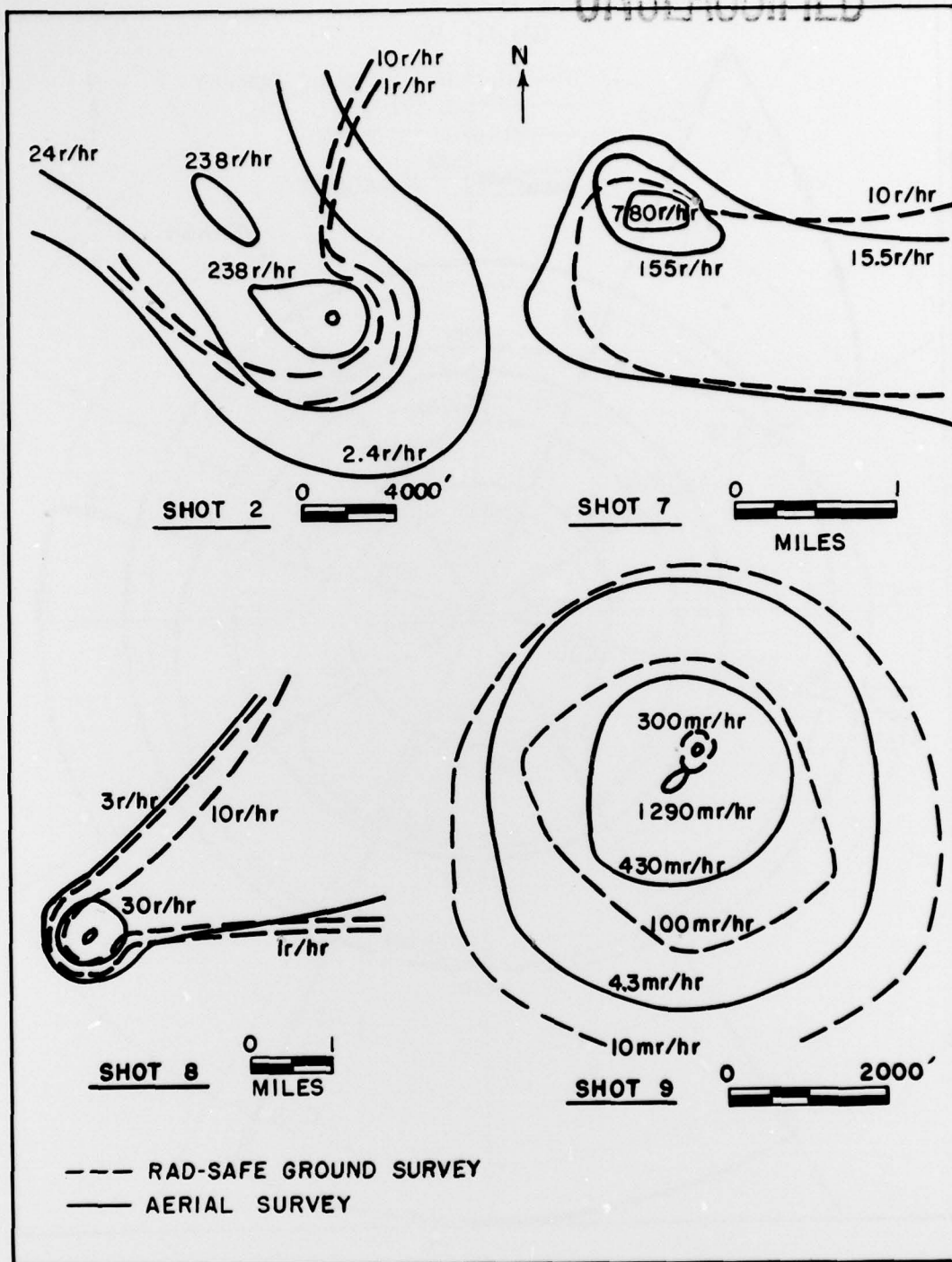


Fig. 3.3 Iso-rate Contours, Shots 2, 7, 8, and 9

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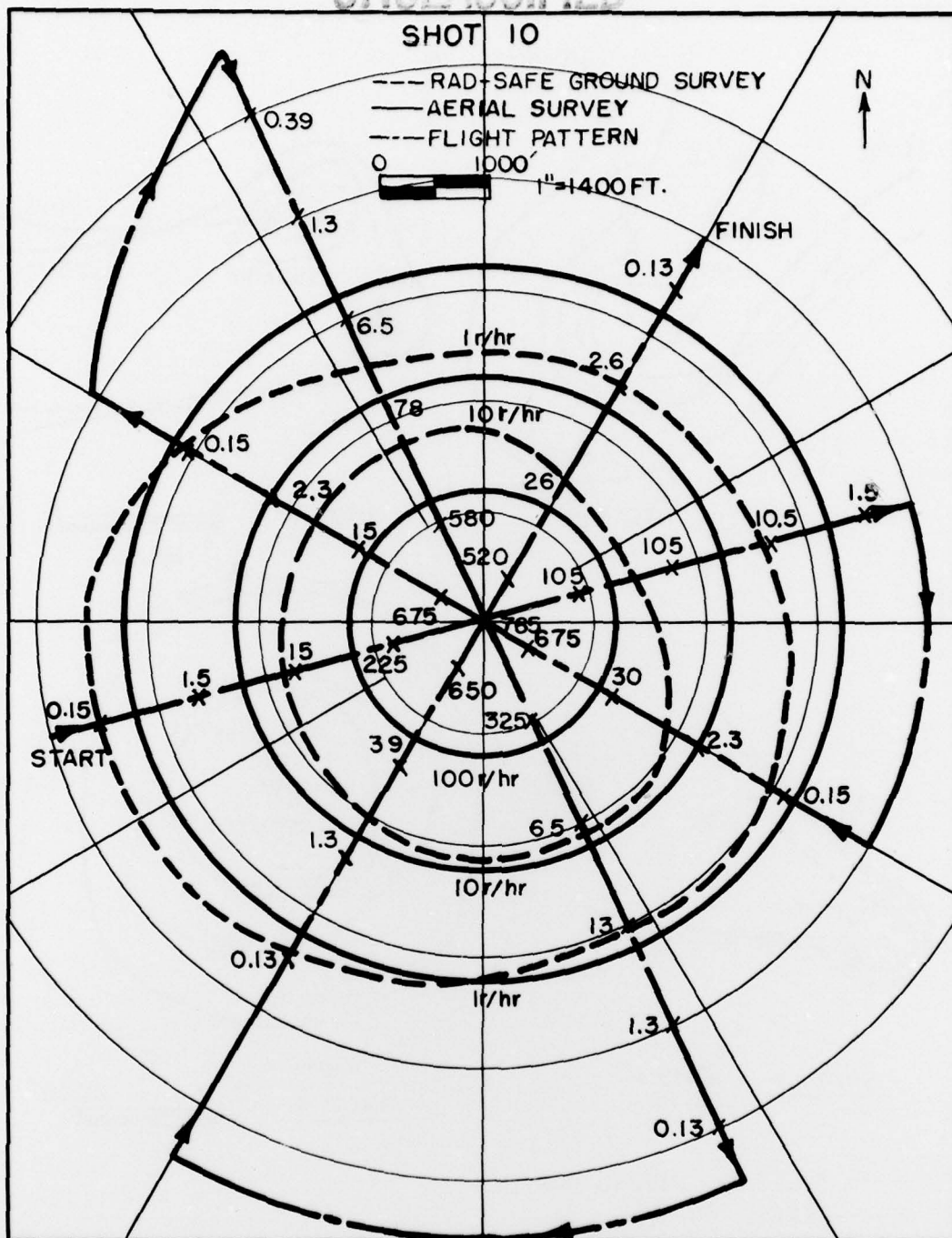


Fig. 3.4 Iso-rate Contours, Shot 10

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## CHAPTER 4

### CONCLUSIONS AND RECOMMENDATIONS

#### 4.1 CONCLUSIONS

An aerial radiological survey results in iso-rate contour which agrees within a factor of ten with those obtained on a ground survey. Helicopters are more suitable than conventional aircraft for performing the survey because of their slower speeds and greater maneuverability. A survey performed at a low altitude is more reliable than one performed at a higher altitude. Maps and landmarks were used effectively to locate the aircraft position.

An aerial survey performed at one altitude together with extrapolation data gives results as good as those obtained by repeating the survey at two other altitudes. The one level survey requires less time and results in data which may be more readily evaluated. The most accurate extrapolation data were obtained by descending in 100 foot intervals on each leg of a figure eight pattern that crisscrossed over a reference point. It is desirable to obtain conversion factors in key areas such as the ground zero area, the downwind fallout area, the 100 r/hr region, and the 1 r/hr region. However, standard extrapolation curves provide conversion factors which may be adequate under many circumstances.

A manual method of recording data is preferred to an electromechanical method. Radiac sets with pseudo-logarithmic scales are preferred to instruments with linear scales. An easily obtained experimental factor is adequate to correct for absorption of radiation by light aircraft.

#### 4.2 RECOMMENDATIONS

It is recommended that simple aerial radiological survey techniques be considered for use as standard tactical doctrine. The surveys should be performed at the lowest altitude commensurate with Rad-Safe considerations using helicopters when possible. A portion of the survey should be performed hovering just over the ground. The radiation rates near physical features and landmarks should be recorded on the data sheet or directly onto a map if possible. The high altitude

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portion of the survey should be performed at one elevation. Conversion factors obtained by making descents over key areas should be used to calculate surface exposure rates. However, standard extrapolation curves provide average conversion factors which may be used if specific extrapolation data are not available. Standard extrapolation curves should be prepared for each type of burst based on data accumulated from aerial surveys.

It is recommended that instruments with psuedo-logarithmic scales be used. A predetermined correction factor should be used under tactical conditions to compensate for the absorption and scattering of gamma radiation by light aircraft.

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APPENDIX A

DATA AND CALCULATIONS FOR A NEAR SURFACE BURST

A.1 CALCULATIONS

The exposure rates listed in Table A.3 are averages of two readings recorded three hours after Shot 10. The following steps were performed to convert this raw data into a finished radiological contour map.

1. A factor to correct for aircraft attenuation was computed from readings of film badges placed inside and outside the aircraft near the radiac instrument.

$$\text{Aircraft shielding correction factor} = \frac{1.5}{0.7} = 2.1 \quad (\text{A.1})$$

2. For purposes of this report it was desirable to compare the aerial survey taken at H / 3 hours to the Rad-Safe initial ground survey taken at H / 1½ hours. Therefore the readings were multiplied by a correction factor determined by the T-1.2 decay relationship. This factor may be obtained from a prepared curve or computed as follows:

$$(r/hr \text{ at } T_1) = (r/hr \text{ at } T_2) \left( \frac{T_1}{T_2} \right)^{-1.2} \quad (\text{A.2})$$

$$(r/hr \text{ at } 1.5 \text{ hrs}) = (r/hr \text{ at } 3 \text{ hrs}) \left( \frac{1.5}{3.0} \right)^{-1.2} \quad (\text{A.3})$$

$$\text{Time correction factor} = 2.3 \quad (\text{A.4})$$

3. a. Since extrapolation data were not taken on this shot a factor was obtained from the standard extrapolation curve shown in Fig. 3.2 to adjust the aerial data to surface rate values.

TABLE A.1 - Altitude vs. Conversion Factor

Altitude (ft)	Conversion Factor
275	2.6
325	3.1

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b. On shots that extrapolation data were taken, they were plotted on semi-logarithmic paper. A curve was drawn through the points and extended to zero altitude as shown in Fig. 3.1. The ratio of the exposure rate at zero altitude to the exposure rate at the altitude where the data was taken provided the required conversion factor.

4. Lumping the three factors calculated above, factors were obtained which converted the readings taken inside the aircraft at  $H \neq 3$  hours at altitudes of 275 and 325 feet to estimated surface rate values at  $H \neq 1\frac{1}{2}$  hours.

TABLE A.2 - Altitude vs. Aggregate Correction Factor

Altitude (ft)	Aggregate Correction Factor
275	$2.1 \times 2.3 \times 2.6 = 13$
325	$2.1 \times 2.3 \times 3.1 = 15$

Multiplying the data in Table A.3 by the above correction factors, the data contained in Table A.4 were obtained.

5. The various columns of Table A.4 were aligned with respect to ground zero and the computed distance from ground zero was substituted in place of time.

$$120 \text{ mph} = 880 \text{ ft/5 sec.} \quad (\text{A.5})$$

$$135 \text{ mph} = 990 \text{ ft/5 sec.} \quad (\text{A.6})$$

6. The exposure rates contained in Table A.4 were then plotted on polar coordinate paper and gamma iso-rate contours were drawn. Figure 3.4 shows this plot together with the Rad-Safe ground survey iso-rate contour map. The cloverleaf pattern flown by the aircraft is also shown together with the adjusted data.

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TABLE A.3 - Aerial Radiological Survey Data Sheet

Shot 10, Time: H / 3 Hours				
Airspeed (mph)	120	120	135	135
Altitude (ft)	325	325	275	275
Bearing (°)	75	300	165	30
Time (sec)	Exposure Rate (r/hr)	Exposure Rate (r/hr)	Exposure Rate (r/hr)	Exposure Rate (r/hr)
5	0.01	0.01	0.03	0.01
10	0.1	0.15	0.1	0.1
15	1.0	2.0	0.5	3.0
20	15.0	45.0	6.0	50.0
25	50 GZ*	50 GZ**	45.0	60 GZ**
30	7.0	45.0	60.0 GZ*	40.0
35	7.0	1.0	25.0	2.0
40	0.7	0.15	5.0	0.2
45	0.1	0.01	1.0	0.01
50			0.1	
55			0.01	

Reading of film badge placed outside of aircraft 1.5r  
 Reading of film badge placed inside of aircraft 0.7r

\*Reading taken over ground zero.

\*\*Reading taken over ground zero about half-way between the 5 second intervals.

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TABLE A.4 - Surface Exposure Rates

Shot 10, Time: H $\neq$ 1 $\frac{1}{2}$ Hours					
Airspeed (mph)	120	120	Airspeed (mph)	135	135
Altitude (ft)	325	325	Altitude (ft)	275	275
Bearing (°)	75°	300°	Bearing (°)	165°	300°
Distance From GZ (ft)	Exposure Rate (r/hr)	Exposure Rate (r/hr)	Distance From GZ (ft)	Exposure Rate (r/hr)	Exposure Rate (r/hr)
4400			4950	0.39	
3960			4455		
3520	0.15		3960	1.3	
3080		0.15	3465		0.13
2640	1.5		2970	6.5	
2200		2.3	2475		1.3
1760	15.0		1980	78.0	
1320		30.0	1485		39.0
880	225.0		990	580.0	
440		675.0	495		650.0
GZ	750.0	750.0	GZ	780.0	780.0
440		675.0	495		520.0
880	105.0		990	325.0	
1320		15.0	1485		26.0
1760	105.0		1980	65.0	
2200		2.3	2475		2.6
2640	10.5		2970	13.0	
3080		0.15	3465		0.13
3520	1.5		3960	1.3	
3960			4455		
4400			4950	0.13	

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York 4, N.Y.
- 25 Commanding General, Second Army, Ft. George G. Meade,  
Md.
- 26 Commanding General, Third Army, Ft. McPherson, Ga.  
ATTN: ACofS, G-3
- 27 Commanding General, Fourth Army, Ft. Sam Houston, Tex.  
ATTN: G-3 Section
- 28 Commanding General, Fifth Army, 1660 E. Hyde Park  
Blvd., Chicago 15, Ill.
- 29 Commanding General, Sixth Army, Presidio of San Fran-  
cisco, Calif. ATTN: AMGCT-4
- 30 Commanding General, U.S. Army Caribbean, Ft. Amador,  
C.Z. ATTN: Cml. Off.
- 31 Commanding General, USARFANT & MDPF, Ft. Brooke,  
Puerto Rico
- 32 Commanding General, U.S. Forces Austria, APO 168, c/o  
PM, New York, N.Y. ATTN: ACofS, G-3
- 33- 34 Commander-in-Chief, Far East Command, APO 500, c/o PM,  
San Francisco, Calif. ATTN: ACofS, J-3
- 35 Commanding General, U.S. Army Forces Far East (Main),  
APO 343, c/o PM, San Francisco, Calif. ATTN: ACofS,  
G-3
- 36 Commanding General, U.S. Army Alaska, APO 942, c/o PM,  
Seattle, Wash.
- 37- 38 Commanding General, U.S. Army Europe, APO 403, c/o PM,  
New York, N.Y. ATTN: OPOT Div., Combat Dev. Br.
- 39- 40 Commanding General, U.S. Army Pacific, APO 958, c/o  
PM, San Francisco, Calif. ATTN: Cml. Off.
- 41 Commandant, Command and General Staff College, Ft.  
Leavenworth, Kan. ATTN: ALLIS(AS)
- 42 Commandant, Army War College, Carlisle Barracks, Pa.  
ATTN: Library
- 43 Commandant, The Artillery School, Ft. Sill, Okla.
- 44 Commandant, The AA&GM Branch, The Artillery School,  
Ft. Bliss, Tex. ATTN: Lt. Col. Albert D. Epley,  
Dept. of Tactics and Combined Arms
- 45 Commanding General, Medical Field Service School,  
Brooks Army Medical Center, Ft. Sam Houston, Tex.
- 46 Director, Special Weapons Development Office, Ft.  
Bliss, Tex. ATTN: Lt. Arthur Jaskierny
- 47 Commandant, Army Medical Service Graduate School,  
Walter Reed Army Medical Center, Washington 25, D.C.
- 48 Superintendent, U.S. Military Academy, West Point, N.Y.  
ATTN: Prof. of Ordnance

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- 49 Commandant, Chemical Corps School, Chemical Corps  
Training Command, Ft. McClellan, Ala.
- 50- 51 Commanding General, Research and Engineering Command,  
Army Chemical Center, Md. ATTN: Deputy for RW and  
Non-Toxic Material
- 52- 54 Commanding General, The Engineer Center, Ft. Belvoir,  
Va. ATTN: Asst. Commandant, Engineer School
- 55 Commanding Officer, Engineer Research and Development  
Laboratory, Ft. Belvoir, Va. ATTN: Chief, Technical  
Intelligence Branch
- 56 Commanding Officer, Picatinny Arsenal, Dover, N.J.  
ATTN: ORDEB-TK
- 57 Commanding Officer, Army Medical Research Laboratory,  
Ft. Knox, Ky.
- 58- 59 Commanding Officer, Chemical Corps Chemical and Radio-  
logical Laboratory, Army Chemical Center, Md. ATTN:  
Tech. Library
- 60 Commanding Officer, Transportation R&D Station, Ft.  
Eustis, Va.
- 61 Commanding General, The Transportation Center and Ft.  
Eustis, Va. ATTN: Military Science &  
Tactics Board
- 62 Director, Technical Documents Center, Evans Signal  
Laboratory, Belmar, N.J.
- 63 Director, Waterways Experiment Station, PO Box 631,  
Vicksburg, Miss. ATTN: Library
- 64 Director, Operations Research Office, Johns Hopkins  
University, 7100 Connecticut Ave., Chevy Chase, Md.  
ATTN: Library
- 65- 71 Technical Information Service, Oak Ridge, Tenn. (Surplus)

NAVY ACTIVITIES

- 72- 73 Chief of Naval Operations, D/N, Washington 25, D.C.  
ATTN: OP-36
- 74 Chief of Naval Operations, D/N, Washington 25, D.C.  
ATTN: OP-374(OEG)
- 75 Director of Naval Intelligence, D/N, Washington 25,  
D.C. ATTN: OP-922V
- 76 Chief, Bureau of Medicine and Surgery, D/N, Washington  
25, D.C. ATTN: Special Weapons Defense Div.
- 77 Chief, Bureau of Ordnance, D/N, Washington 25, D.C.
- 78 Chief of Naval Personnel, D/N, Washington 25, D.C.
- 79- 80 Chief, Bureau of Ships, D/N, Washington 25, D.C. ATTN:  
Code 348
- 81 Chief, Bureau of Yards and Docks, D/N, Washington 25,  
D.C. ATTN: D-440
- 82 Chief, Bureau of Supplies and Accounts, D/N, Washing-  
ton 25, D.C.
- 83- 84 Chief, Bureau of Aeronautics, D/N, Washington 25, D.C.
- 85 Commander-in-Chief, U.S. Pacific Fleet, Fleet Post  
Office, San Francisco, Calif.
- 86 Commander-in-Chief, U.S. Atlantic Fleet, U.S. Naval  
Base, Norfolk 11, Va.
- 87- 90 Commandant, U.S. Marine Corps, Washington 25, D.C.  
ATTN: Code A03H
- 91 President, U.S. Naval War College, Newport, R.I.
- 92 Superintendent, U.S. Naval Postgraduate School,  
Monterey, Calif.
- 93 Commanding Officer, U.S. Naval Schools Command, U.S.  
Naval Station, Treasure Island, San Francisco,  
Calif.
- 94 Commanding Officer, U.S. Fleet Training Center, Naval  
Base, Norfolk 11, Va. ATTN: Special Weapons School
- 95 Commanding Officer, U.S. Fleet Training Center, Naval  
Station, San Diego 36, Calif. ATTN: (SPWP School)

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- 96 Commanding Officer, U.S. Naval Damage Control Training Center, Naval Base, Philadelphia 12, Pa. ATTN: ABC Defense Course
- 97 Commanding Officer, U.S. Naval Unit, Chemical Corps School, Army Chemical Training Center, Ft. McClellan, Ala.
- 98 Joint Landing Force Board, Marine Barracks, Camp Lejeune, N.C.
- 99 Commander, U.S. Naval Ordnance Laboratory, Silver Spring 19, Md. ATTN: R
- 100 Commander, U.S. Naval Ordnance Test Station, Inyokern, China Lake, Calif.
- 101 Officer-in-Charge, U.S. Naval Civil Engineering Res. and Evaluation Lab., U.S. Naval Construction Battalion Center, Port Hueneme, Calif. ATTN: Code 753
- 102 Commanding Officer, U.S. Naval Medical Research Inst., National Naval Medical Center, Bethesda 14, Md.
- 103 Director, U.S. Naval Research Laboratory, Washington 25, D.C. ATTN: Code 2029
- 104 Director, The Material Laboratory, New York Naval Shipyard, Brooklyn, N.Y.
- 105 Commanding Officer and Director, U.S. Navy Electronics Laboratory, San Diego 52, Calif. ATTN: Code 4223
- 106-109 Commanding Officer, U.S. Naval Radiological Defense Laboratory, San Francisco 24, Calif. ATTN: Technical Information Division
- 110 Commanding Officer and Director, David W. Taylor Model Basin, Washington 7, D.C. ATTN: Library
- 111-112 Commanding Officer, U.S. Naval Photographic Center, Anacostia, D.C.
- 113 Commander, U.S. Naval Air Development Center, Johnsville, Pa.
- 114 Director, Office of Naval Research Branch Office, 1000 Geary St., San Francisco, Calif.
- 115 Officer-in-Charge, U.S. Naval Clothing Factory, U.S. Naval Supply Activities, New York, 3rd Avenue and 29th Street, Brooklyn, N.Y. ATTN: R&D Division
- 116 Commandant, U. S. Coast Guard, 1300 E. St. N.W. Washington 25, D.C., ATTN: Capt. F. S. Eastman
- 117-125 Technical Information Service, Oak Ridge, Tenn. (Surplus)

AIR FORCE ACTIVITIES

- 126 Asst. for Atomic Energy, Headquarters, USAF, Washington 25, D.C. ATTN: DCS/O
- 127 Director of Operations, Headquarters, USAF, Washington 25, D.C. ATTN: Operations Analysis
- 128 Director of Plans, Headquarters, USAF, Washington 25, D.C. ATTN: War Plans Div.
- 129 Director of Research and Development, Headquarters, USAF, Washington 25, D.C. ATTN: Combat Components Div.
- 130-131 Director of Intelligence, Headquarters, USAF, Washington 25, D.C. ATTN: APOIN-1B2
- 132 The Surgeon General, Headquarters, USAF, Washington 25, D.C. ATTN: Bio. Def. Br., Pre. Med. Div.
- 133 Asst. Chief of Staff, Intelligence, Headquarters, U.S. Air Forces Europe, APO 633, c/o PM, New York, N.Y. ATTN: Air Intelligence Branch
- 134 Commander, 497th Reconnaissance Technical Squadron (Augmented), APO 633, c/o PM, New York, N.Y.
- 135 Commander, Far East Air Force, APO 925, c/o PM, San Francisco, Calif.
- 136 Commander, Strategic Air Command, Offutt Air Force Base, Omaha, Nebraska. ATTN: Special Weapons Branch, Inspection Div., Inspector General
- 137 Commander, Tactical Air Command, Langley AFB, Va. ATTN: Documents Security Branch
- 138 Commander, Air Defense Command, Ent AFB, Colo.
- 139-140 Commander, Air Materiel Command, Wright-Patterson AFB, Dayton, O. ATTN: MCAIDS
- 141 Commander, Air Training Command, Scott AFB, Belleville, Ill. ATTN: DCS/O GTP

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- 142 Commander, Air Research and Development Command, PO Box 1395, Baltimore, Md. ATTN: RUDN
- 143 Commander, Air Proving Ground Command, Eglin AFB, Fla. ATTN: AG/TRB
- 144-145 Commander, Air University, Maxwell AFB, Ala.
- 146-153 Commander, Flying Training Air Force, Waco, Tex. ATTN: Director of Observer Training
- 154 Commander, Crew Training Air Force, Randolph Field, Tex. ATTN: 20TS, DCS/O
- 155 Commander, Headquarters, Technical Training Air Force, Gulfport, Miss. ATTN: T&D
- 156-157 Commandant, Air Force School of Aviation Medicine, Randolph AFB, Tex.
- 158-160 Commander, Wright Air Development Center, Wright-Patterson AFB, Dayton, O. ATTN: WCOESP
- 161 Commander, Air Force Cambridge Research Center, 230 Albany Street, Cambridge 39, Mass. ATTN: CRW, Atomic Warfare Directorate
- 162 Commander, Air Force Cambridge Research Center, 230 Albany Street, Cambridge 39, Mass. ATTN: CR&ST-2
- 163-165 Commander, Air Force Special Weapons Center, Kirtland AFB, N. Mex. ATTN: Library
- 166 Commandant, USAF Institute of Technology, Wright-Patterson AFB, Dayton, O. ATTN: Resident College
- 167 Commander, Lowry AFB, Denver, Colo. ATTN: Department of Armament Training
- 168 Commander, 1009th Special Weapons Squadron, Headquarters, USAF, Washington 25, D.C.
- 169-170 The RAND Corporation, 1700 Main Street, Santa Monica, Calif. ATTN: Nuclear Energy Division
- 171-178 Technical Information Service, Oak Ridge, Tenn. (Surplus)

OTHER DEPARTMENT OF DEFENSE ACTIVITIES

- 179 Asst. Secretary of Defense, Research and Development, D/D, Washington 25, D.C.
- 180 U.S. National Military Representative, Headquarters, SHAPE, APO 55, c/o PM, New York, N.Y. ATTN: Col. J. P. Healy
- 181 Director, Weapons Systems Evaluation Group, OSD, RM 2E1006, Pentagon, Washington 25, D.C.
- 182 Commandant, Armed Forces Staff College, Norfolk 11, Va. ATTN: Secretary
- 183-188 Commanding General, Field Command, Armed Forces Special Weapons Project, PO Box 5100, Albuquerque, N. Mex.
- 189-197 Chief, Armed Forces Special Weapons Project, PO Box 2610, Washington 13, D.C.
- 198 Commanding General, Military District of Washington Room 1543, Bldg. T-7, Gravelly Point, Va.
- 199-200 Commanding General, Field Command, Armed Forces Special Weapons Project, PO Box 5100, Albuquerque, N. Mex. ATTN: Technical Training Group
- 201-205 Technical Information Service, Oak Ridge, Tenn. (Surplus)

ATOMIC ENERGY COMMISSION ACTIVITIES

- 206-208 U.S. Atomic Energy Commission, Classified Technical Library, 1901 Constitution Ave., Washington 25, D.C. ATTN: Mrs. J. M. O'Leary (For DMA)
- 209-211 Los Alamos Scientific Laboratory, Report Library, PO Box 1663, Los Alamos, N. Mex. ATTN: Helen Redman
- 212-213 Sandia Corporation, Classified Document Division, Sandia Base, Albuquerque, N. Mex. ATTN: Martin Lucero
- 214-215 University of California Radiation Laboratory, PO Box 808, Livermore, Calif. ATTN: Margaret Edlund
- 216 Weapon Data Section, Technical Information Service, Oak Ridge, Tenn.
- 217-275 Technical Information Service, Oak Ridge, Tenn. (Surplus)

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